



LHAPDF/LHAGLUE at CDF

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See: [hep-ph/0508110](https://arxiv.org/abs/hep-ph/0508110)

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Outline

- LHAPDF library
- LHAGLUE interface
 - PYTHIA
 - HERWIG, MC@NLO
 - Others? You tell us.
- LHAPDF at CDF



LHAPDF

- Contains “modern” PDFs
 - CTEQ6M, error sets...
- Retains “legacy” PDFs
 - CTEQ5L ...
- With LHAGLUE behaves like PDFLIB
- Complete replacement for PDFLIB!



The Proton PDF sets available in LHAPDF

Prefix	Suffix (# of sets)	type	LHAGLUE numbers
alekhin_-	100 (100), 1000 (1000)	p	40100-200, 41000-1999
a02m_-	lo (17), nlo (17), nnlo (17)))	g	40350-67, 40450-67, 40550-67
botje_-	100 (100),1000 (1000)	p	50100-200, 51000-1999
CTEQ	61 (41)	p,g	10100-40 , 10150-90
CTEQ	6 (41)	p,g	10000-40 , 10050-90
CTEQ	6m, 6l, 6ll	p	10040, 10041, 10042
CTEQ	5m, 5m1, 5d, 5l	g	19050, 19051, 19060, 19070
CTEQ	4m, 4d, 4l	g	19150, 19160, 19170
fermi2002_-	100 (100), 1000 (1000)	p	30100-200, 31000-2000
GRV98	lo, nlo(2)	g	80060, 80050-1
H12000	msE (21), disE (21), loE (21)	g	70050-70, 70150-70, 70250-70
MRST2004	nlo	p,g	20400 , 20450
MRST2004	nnlo	g	20470
MRST2003	cnlo	p,g	20300 , 20350
MRST2003	cnnlo	g	20370
MRST2002	nlo (2)	p,g	20200 , 20250
MRST2002	nnlo	g	20270
MRST2001	E (31)	p,g	20100-130 , 20150-180
MRST2001	nlo(4)	p,g	20000-4 , 20500-4
MRST2001	lo, nnlo	g	20060, 20070
MRST98	(3)	p	29000-3
MRST98	lo (5), nlo (5) dis (5), ht	g	29040-5, 29050-5,29060-5,29070-5
ZEUS2002_-	TR (23), FF (23), ZM (23)	p	60000-22, 60100-22, 60200-22
ZEUS2005_-	ZJ (23)	p	60300-22



Using LHAPDF

- Download the code : <http://heforge.cedar.ac.uk/lhapdf/>
- Follow instructions there to compile library.
- Link the library, libLHAPDF.a, with code.

Commands available to user

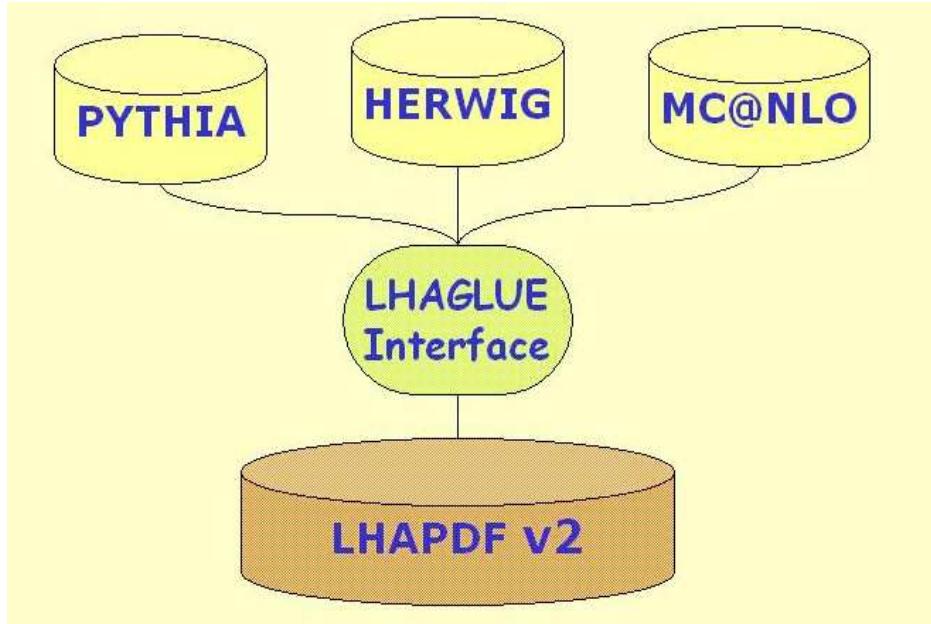
- Initialization (selecting the required PDF set and its member)
- Evolution (producing the momentum density functions (f) for the partons at selected x and Q)
- Information (displaying for example α_s , descriptions, etc.)



call InitPDFset(<i>name</i>)	Initializes the PDF set to use.
call InitPDF(<i>member</i>)	Selects the member from the above PDF set.
call evolvePDF(<i>x,Q,f</i>)	Returns the momentum density function, $f(x, Q)$, for protons or pions.
call evolvePDFp(<i>x,Q,P2,ip2,f</i>)	Returns the momentum density function for photons. ^a .
call numberPDF(<i>num</i>)	Returns the number (<i>num</i>) of PDF members in the set.
call GetDesc()	Prints a description of the PDF set.
alphasPDF(<i>Q</i>)	Function giving the value of α_s at <i>Q</i> GeV.
call GetLam4,5(<i>mem,qcdl4,5</i>)	Returns the value of $\Lambda_{4,5}^{QCD}$ for the specific member.
call GetOrderPDF,As(<i>order</i>)	Returns the order of the PDF, α_s evolution.
call GetRenFac(<i>muf</i>)	Returns the renormalisation factor.
call GetQmass(<i>nf,mass</i>)	Returns the mass of the parton of flavour <i>nf</i> .
call GetThreshold(<i>nf,Q</i>)	Returns the threshold value for parton of flavour <i>nf</i> .
call GetNf(<i>nfmax</i>)	Returns the number of flavours.



The LHAGLUE Interface



- LHAGLUE uses the same 'hooks' as PDFLIB.
- No further modification of HERWIG or PYTHIA source code is needed.
- LHAGLUE is part of the LHAPDF library.
 - Simple to move from PDFLIB to LHAGLUE
- Quark and gluon PDFs have been checked for consistency with all PDFs available for CDF energy. → Interface is reliable for all PDFs



LHAGLUE Subroutines

Command	Description
call PDFSET(<i>parm,value</i>)	For initialization (called once) where PARM and VALUE are LOCAL arrays → CHARACTER*20 PARM(20) → DOUBLE PRECISION VALUE(20))
call STRUCTM(<i>X,Q,UPV,DPV,USEA,DSEA,STR,CHM,BOT,TOP,GLU</i>)	For the proton PDFs: where X and Q are the input variables and the rest are the output PDF quarks and the gluon.
call STRUCTP(<i>X,Q2,P2,IP2,UPV,DPV,USEA,DSEA,STR,CHM,BOT,TOP,GLU</i>)	For the photon PDFs.



Use with Herwig and Pythia

- PYTHIA mode

PARM(1) = 'NPTYPE' ← set automatically in PYTHIA

In this case the user must supply MSTP(51) and MSTP(52) in the PYTHIA common block

COMMON/PYPARS/MSTP(200),PARP(200),MSTI(200).PARI(200)

MSTP(52) = 2 ← to use an external PDF library

MSTP(51)= “*PDF number*”

- HERWIG mode

PARM(1) = 'HWLHAPDF'← set by the user.

In this case one sets for the beam and target particles separately

AUTPDF(1) = 'HWLHAPDF'

AUTPDF(2) = 'HWLHAPDF'

MODPDF(1) = “*PDF number*”

MODPDF(2) = “*PDF number*”



Miscellaneous

- Naming of some subroutines seems to conflict with ISAJET
→ Should be able to fix this internally
- MC@NLO (NLO PDFs!)
- Interest in CTEQ6M new gluon PDFs.
- PDFSets directory
- PARM(1)(for HERWIG)



Summary

- LHAPDF and LHAGLUE are ready for use.
- In use at CMS, ATLAS, HERA, and D0
- Complete replacement for PDFLIB



For complete documentation...

- hep-ph/0508110
- <http://www.cedar.ac.uk/lhapdf/>